A BIOMECHANICAL ANALYSIS OF THE INSTEP KICK IN SOCCER WITH PREFERRED AND NON-PREFERRED FOOT

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This study examined the kinematics of preferred and non-preferred instep kicking action in competitive soccer players. Using two gen-locked cameras, SHVS video data were obtained for seven players completing eight maximal effort instep kicks at a target with both feet. 3D kinematic analysis was carried out using Peak Motus to obtain joint angles of the standing and kicking legs and the frontal plane pelvic tilt angle. The results showed that when kicking with the preferred limb, the players' standing foot was closer to the ball and they used a larger frontal plane pelvic tilt angle and greater knee extension of the kicking leg at ball impact. There was greater variability in the kicking leg knee angle and this is consistent with Dynamical Systems Theory.

KEY WORDS: laterality, kinematics, dynamical systems.

INTRODUCTION: Foot preference is always a relevant issue in soccer. The tactical nature of the game means that certain positions often reward the ability to play with a particular foot. Many coaches believe that it is desirable for players to be able to use either foot equally well and that excessive one-sidedness would be a disadvantage. "A player therefore, who is one footed, no matter how efficient technically that foot may be, would be even better if he were efficient with the other foot as well" (Hughes, 1999). It is rather surprising then that in an analysis of elite players in the FIFA 1998 World Cup, Carey et al (2001) found that elite player had similar levels of preference for one foot as the general population.
Given the apparent desirability of bilateral kicking skill in the game, studies comparing preferred and non-preferred legs are quite few. McLean and Tumilty (1993) studied of kicking asymmetry in two types of kick. They showed a low correlation between isokinetic strength and ball speed, most likely due to an accuracy element in the skill selected. They also noted foot plant differences between the preferred and non preferred sides. Lees and Nolan (1998) also noted the significant difference between preferred and non-preferred feet for foot plant distance. Few if any studies, have examined differences in the kinematics of the hip or pelvis between preferred and non preferred legs which is surprising since the kicking action can be considered to originate from this area of the body.
The aim of this investigation was to examine kinematic differences in lower limb action when kicking with the preferred and non-preferred feet in trained competitive soccer players. The analysis focussed on the kinematics of the hip/pelvis as well as the movements of the standing and kicking legs.

METHOD:

Subjects: Seven male intervarsity level soccer players (Mean age = 19.9 ±0.8 years) volunteered to participate to this study. The participants all had at least two years experience of playing at this level and were judged by an experienced EUFA B licensed coach to have good technique at instep kicking with their preferred foot. Participants who considered they had equal kicking ability on both legs were excluded.
Subject preparation : Participants wore dark coloured Lycra™ cycling shorts and tight fitting vests. Spherical markers were fixed to the players' right and left legs using adhesive tape and Velcro straps on the following positions: anterior superior iliac spines, upper anterior surface of the thigh (15 cm below hip joint), lower anterior surface of the thigh (10 cm above knee joint), lower border of tibial tuberosity, anterior surface of shank (10 -15 cm above medial malleolus), lateral side of the foot at $^1/_3$ of foot length proximal from the toe.

Procedures: All participants were required to perform eight maximal effort, instep kicks at a target, firstly with their non-preferred foot and then with their preferred foot. They were allowed a full recovery between trials.
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Video Analysis : All trials were recorded on SVHS video tape (50Hz) using two, gen-locked Panasonic AGDP800 cameras placed diagonally, right and left, in front of the kicker. 3D kinematic analysis of the video sequences was carried out using the Peak Motus™ video analysis system, (Peak Performance Technologies Inc., Colorado). The video sequences were digitized at a frequency of 50Hz. The raw coordinate data was smoothed using a general cross-validated quintic spline algorithm. From these data, the following parameters were obtained: Lateral Pelvic tilt angle (LPA), self selected approach angle (SAA), distance between the standing foot and ball centre at foot plant (FPdist), standing leg knee angle at ball contact (SKA) and kicking leg knee angle at ball contact (KKA). LPA was defined as the angle between the line joining the two ASIS points and the horizontal. SAA was defined as the angle formed by the YZ (i.e. sagittal) plane and a virtual line joining the midpoint between the two ASIS markers at the start of the approach to the moment of foot plant on the standing leg. FPdist was defined as the distance between the foot marker and the ball centre during stance. SKA was defined as the angle between the thigh and shank segments of the standing leg at ball contact. KKA was defined as the angle between the thigh and shank segments of the kicking leg at ball contact.
Data Analysis: These parameters were statistically analysed in SPSS 11.0, using General Linear Model, ANOVA with two repeated measures factors, namely, leg (with two levels preferred and non-preferred) and trials (with eight levels). The significance level of $p \le 0.05$ was used and partial eta^2 (η_p^2) was used to indicate effect sizes. Effect sizes were interpreted using the scale: $\eta_p^2 < 0.25 \Rightarrow$ "small"; $0.26 > \eta_p^2 < 0.58 \Rightarrow$ "large"; $\eta_p^2 > 0.80 \Rightarrow$ "very large".

RESULTS: Figures 1 to 4 show comparisons of the means and SD's between preferred and non-preferred kicking conditions for KKA, LPA, FPdist and SAA. The results show that KKA was significantly larger for the preferred leg ($p = 0.009$; $\eta_p^2 = 0.71$ [large]), indicating the knee angle of the kicking leg was more extended at ball impact. Lateral pelvic tilt angle was significantly smaller in the non-preferred condition ($p = 0.002$; $\eta_p^2 = 0.83$ [very large]) indicating that participants kicked the ball with greater pelvic tilt (relative to horizontal) when using their preferred leg.

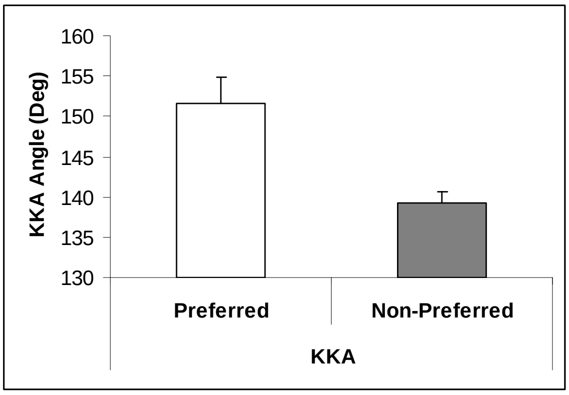


Figure 1: Mean and SD of KKA for preferred and non-preferred legs

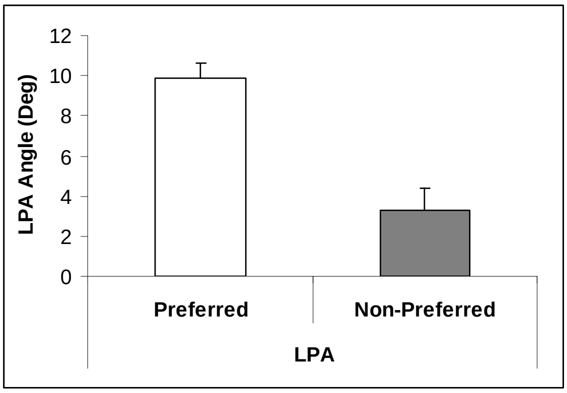
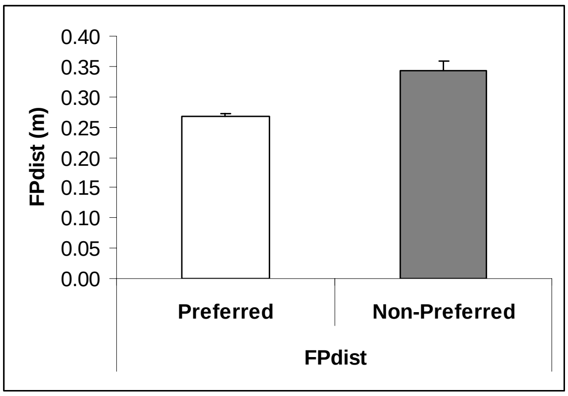


Figure 2: Mean and SD of LPA for preferred and non-preferred legs

The FPdist results show that participants tended to place their standing foot significantly closer to the ball when kicking with their preferred foot, ($p = 0.001$; $\eta_p^2 = 0.87$ [very large]).

The SAA results show that when participants kicked with their preferred leg they approached the ball with a significantly straighter approach run (p = 0.034; η_p^2 = 0.55 [medium]).



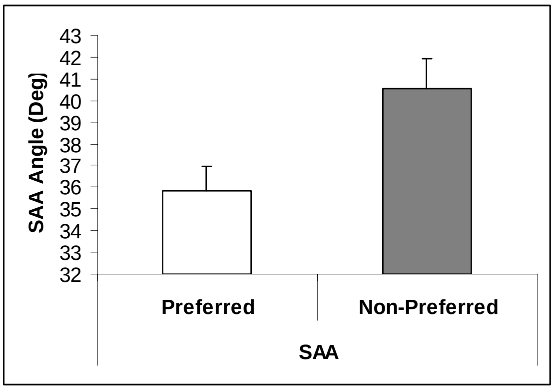
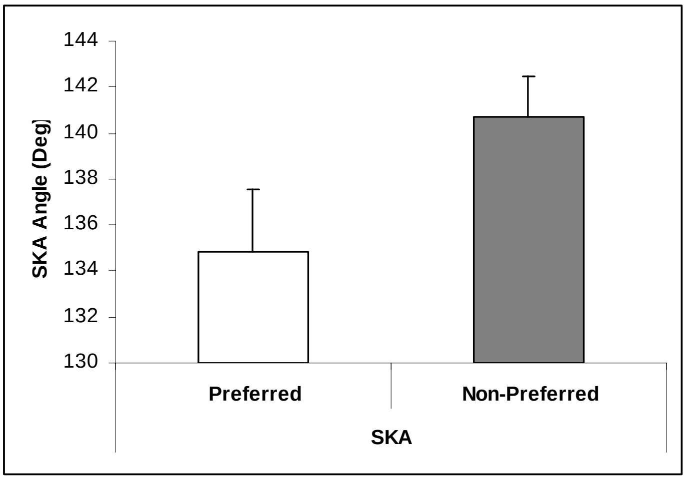


Figure 3: Mean and SD of FPdist for preferred and non-preferred legs

Figure 4: Mean and SD of SAA for preferred and non-preferred legs

Figure 5 compares the mean SKA scores when kicking with preferred and non-preferred legs. The results show no statistically significant difference in SKA between preferred and non-preferred conditions, (p = 0.080). Figure 6 illustrates the average stick figure of the preferred and non-preferred kicking conditions at ball impact.



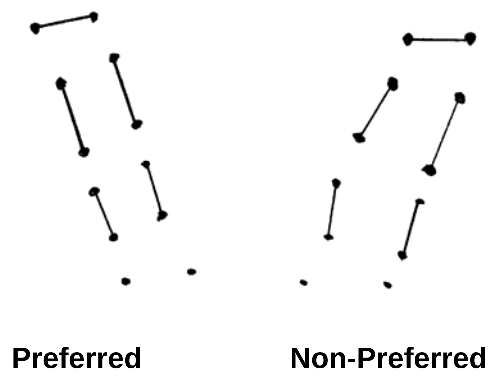


Figure 5: Mean and SD of SKA for preferred and non-preferred legs

Figure 6: Average stick figure at ball contact for preferred and non-preferred conditions

DISCUSSION: Inspection of the data in this study demonstrates that there were clear differences between preferred and non-preferred kicking actions in KKA, LPA, FPdist and SAA. The results indicated that when using their preferred leg participants used a straighter approach run, placed their standing foot closer to the ball and kicked the ball with greater pelvic tilt and knee extension on the kicking leg. The smaller FPdist in the preferred condition is consistent with the results of previous research by Mclean and Tumilty (1993) who suggested the greater FPdist in the non-preferred condition might allow a larger kicking arc and thus compensate for lower power in the quadriceps muscles of the non-preferred leg by allowing the leg to accelerate through a longer distance. This interpretation is not supported by the analysis of other parameters in this study. The LPA data show that players kicked with a larger pelvic tilt in the preferred condition and this pelvic tilt would have a tendency increase the kicking arc in the preferred condition by encouraging players to lean away from the ball more on the standing leg see figure 6. The smaller knee angle on the non-preferred condition could result in a longer contact time with the ball and this may be an important

factor because a longer contact time may allow greater control of the direction of the kick with the non-preferred leg.
It is also noteworthy that the variability of FPdist score in the preferred condition was approximately 4.8 times smaller than non-preferred condition. In contrast KKA in the preferred condition is approximately 2.5 times more variable than the non-preferred condition. The role of variability in movement is thought play an important role in the learning and control of complex motor tasks. While early research on performance of motors skills considered variability as errors (Schmidt et al., 1979), Dynamical Systems Theory research considers higher variability in the process of motor tasks as a characteristic that is typical of high level performance. Good performers are characterised by low variability in outcome measures but high variation in the coordination of muscles and joint actions used to achieve these outcome measures (Glazier et al., 2003). The relatively higher variability of the knee angle of the kicking leg in the preferred condition is consistent with Dynamical System Theory predictions of higher variability in the more skilled action. By contrast, there is lower variability of FPdist in the preferred condition. This suggests that FPdist may be more closely linked to the outcome measure, (power and accuracy of the kick) and therefore have less scope for variability. The dependency of the outcome measure on FPdist cannot be established with the existing experimental data therefore further study would be required to verify this. An alternative view is that a closer FPdist is a feature of performance that is coached and this leads to reduced scope for variation in this parameter.

CONCLUSION: The results indicated that when using their preferred leg, players used a straighter approach run, placed their standing foot closer to the ball and kicked the ball with greater pelvic tilt and knee extension on the kicking leg.

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